Article

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My farewell to *Science and Civilisation in China*

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Abstract
The author served as General Editor of the *Science and Civilisation in China* series from 1992 to 2014. He reviews the history of this scholarly project since its inception by Joseph Needham in 1943, and discusses some of the problems that had to be solved in the production of such a complex and far-ranging publication. He illustrates the discussion with reference to three of the books in the series that appeared under his editorship – those dealing with the topics of ceramics, ferrous metallurgy and ethnobotany.

Keywords
Joseph Needham, *Science and Civilisation in China*, Needham Research Institute

1. The conception of *Science and Civilisation in China*

The aim of this essay is to share some of the experiences I had as General Editor of Joseph Needham's *Science and Civilisation in China* series in the 22 years that I fulfilled that role between 1992, when Joseph Needham and Ho Peng Yoke (then Director of the Needham Research Institute) asked me to take on this responsibility, and my retirement in 2014.[1] A remark often wrongly attributed to Otto von Bismarck says, in effect, that if people knew how sausage was made, nobody would want to eat any.[2] In this essay, rather than discussing the scholarly significance of *Science and Civilisation in China*, which many have done before me, I shall try to make use of my experience as editor of the series to describe something of 'how [at least some parts of] the sausage was made' – hoping that, despite the fears wrongly ascribed to Bismarck, this will not deter readers from wanting to serve themselves another slice.

First, it will be helpful for me to outline the early stages of the *Science and Civilisation in China* (SCC) project – and how the series developed from its original simplicity to the complex series of books that it eventually became. In May 1943 – the year that he arrived in China – Joseph Needham sketched an 'ideas map' (Figure 1). Such was his normal practice whenever he wanted to plan an article or a talk. This one, however, was the most important ideas map of his entire career, for although he did not know it at the time, the project that grew from it was to occupy the great majority of his time and energy for the next half-century.

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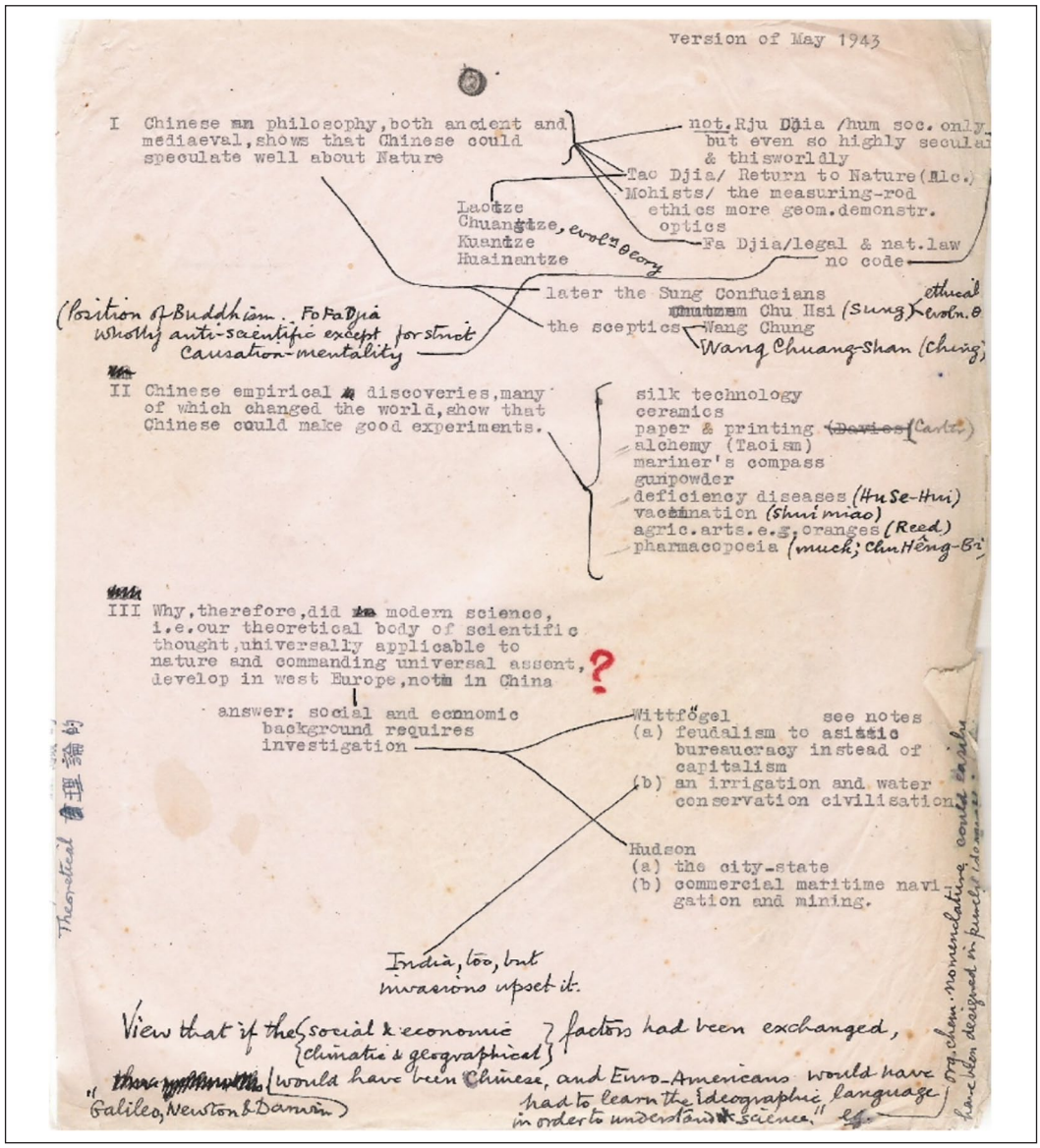


Figure 1. Needham's 'ideas map' for the SCC project.

The sheet of paper in question does not tell us that it is the plan of a book. It may simply have been the outline for one of the many lectures that he gave in the course of his visits to academic institutions as part of his travels all over Free China from 1943 to 1946. But anyone who looks at this document with hindsight can see that the essentials of SCC are all present: the initial survey of Chinese traditions of thought about nature from the early Daoists to Zhu Xi, the core of a detailed history of the technical fertility of Chinese civilisation, covering everything from ceramics and gunpowder to the pharmacopoeia, all set in the context of an abiding interest in the relations between the ways people think and the social and political structures that shape and constrain their actions.

Secretary: S. C. Roberts, M.A.
Assistant Secretary: F. H. Kendon, M.A.
Telephone: 4226

University Press
CAMBRIDGE

22 May 1948

My dear Needham,

I am glad to be able to tell you that the Syndics' reception of your proposal for a work on Science and Civilisation in China was entirely sympathetic. They would like to re-enforce the view that it is most desirable that the material should be included in one volume.

I shall not, I am afraid, be personally concerned in the actual publication, but I have no doubt that when the time comes the Syndics will propose an agreement on a royalty basis, and I will, in any event, pass on what you say about the use of a certain number of Chinese characters to our Printing Department.

Yours sincerely,

S.C. Roberts

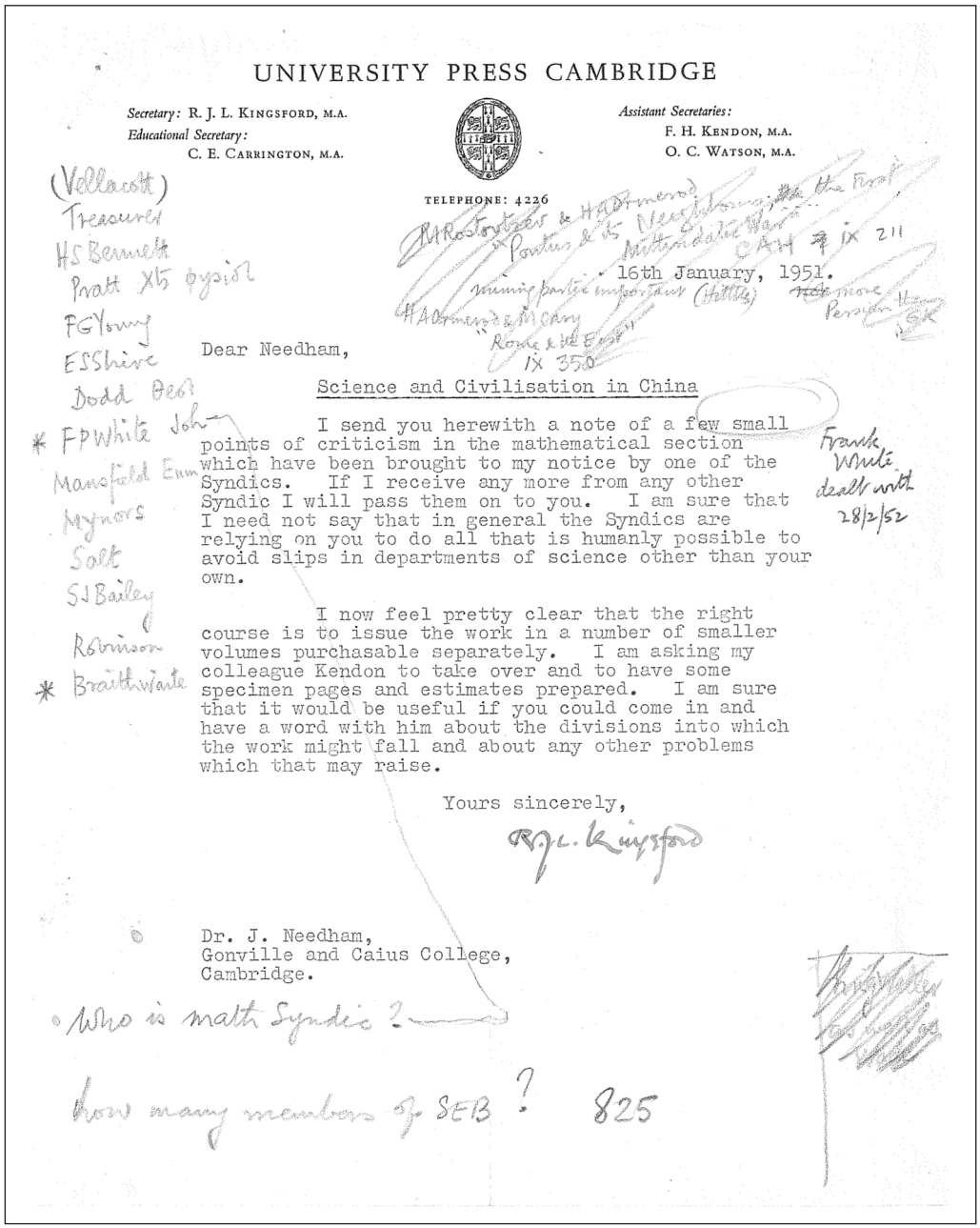
Dr. J. Needham,
Caius College,
Cambridge.

Figure 2. Letter from Cambridge University Press in 1948.

After a relatively brief post-war period at UNESCO in Paris, Needham returned to Cambridge. He does not seem to have waited long before setting out his plans to write a history of science, technology and medicine in China, in the fullest social, intellectual, economic and political context, from original sources. We have the letter of 22 May 1948 in which the Syndics of Cambridge University Press expressed their willingness to consider such a book for publication (Figure 2). They acknowledged that the printing department would have to be warned that the book would contain 'a certain number of Chinese characters', which it certainly did. We can perhaps detect a slight nervousness in the Secretary's note that in the view of the Syndics, it was 'most desirable that the material should be included in one volume', which, as we shall see, it certainly was not.

2. The seven-volume scheme

The Syndics' original agreement was to publish a single volume by Needham. Whether or not that was also Needham's intention is unclear. But a little over 2 years later, in January 1951 (Figure 3), another Secretary to the Syndics wrote saying that it was pretty clear that 'the right course [was] to issue the work in a number of smaller volumes purchasable separately'. It may be that the Syndics were already beginning to become apprehensive at the sheer bulk of material that Needham was preparing in draft



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Assistant Secretaries:
F. H. KENDON, M.A.
O. C. WATSON, M.A.

TELEPHONE: 4226

16th January, 1951.

Dear Needham,

Science and Civilisation in China

I send you herewith a note of a few small points of criticism in the mathematical section which have been brought to my notice by one of the Syndics. If I receive any more from any other Syndic I will pass them on to you. I am sure that I need not say that in general the Syndics are relying on you to do all that is humanly possible to avoid slips in departments of science other than your own.

I now feel pretty clear that the right course is to issue the work in a number of smaller volumes purchasable separately. I am asking my colleague Kendon to take over and to have some specimen pages and estimates prepared. I am sure that it would be useful if you could come in and have a word with him about the divisions into which the work might fall and about any other problems which that may raise.

Yours sincerely,

R. J. L. Kingsford

Dr. J. Needham,
Gonville and Caius College,
Cambridge.

Figure 3. Letter from Cambridge University Press in 1951.

– from the letter, it is clear that they had already seen material he was preparing on mathematics, a topic that was not planned to appear in print until volume 3. In any case, in accordance with the Syndics' decision, the first three volumes of the series appeared in 1954, 1956 and 1959. The 1954 volume set out the first published plan of Needham's work. This core plan, which remained constant during the

whole of the time Needham worked on SCC, was based on a division into 50 topical sections – from '1: Preface' to '50: General conclusions'. These were to be distributed over seven physical volumes, arranged under broad topical titles, as follows[3]:

- Volume 1: *Introductory Orientations*
- Volume 2: *History of Scientific Thought*
- Volume 3: *Mathematics and the Sciences of the Heavens and Earth*
- Volume 4: *Physics and Physical Technology*
- Volume 5: *Chemistry and Chemical Technology*
- Volume 6: *Biology and Biological Technology*
- Volume 7: *The Social Background*

Volumes 1, 2 and 3 appeared in fairly rapid succession in 1954, 1956 and 1959, an excellent rate of publication for a scholarly series mostly written by one person. But then things changed quite markedly, as we shall now see.

3. The plan proliferates

Up to the end of the 1950s, there were no signs that Needham planned to depart from the seven-volume plan agreed with the press early in that decade. By 1962, however, it became clear that Needham had other ideas – and indeed must have had them for some time, given the time required to research and write books of the kind Needham was producing. Volume 4, *Physics and Physical Technology*, was originally planned as a single book containing four sections. But in that year, there appeared a book containing only one of the planned sections, with the rest of the volume scheduled to appear as two further physical books. As a result, volume 4 appeared in three parts as follows:

- Volume 4: *Physics and Physical Technology*
  - Part 1: Physics. Joseph Needham, with the research assistance of Wang Ling, and the special co-operation of Kenneth Robinson (published in 1962 and contains section 26)
  - Part 2: Mechanical Engineering. Joseph Needham, with the collaboration of Wang Ling (published in 1965 and contains section 27)
  - Part 3: Civil Engineering and Nautics. Joseph Needham, with the collaboration of Wang Ling and Lu Gwei-djen (published in 1971 and contains sections 28 and 29)

From this time on, someone speaking of a 'volume' of SCC might mean either the large-scale division into volumes 1 to 7 or the actual physical books published by Cambridge University Press. Needham himself recognised the distinction by labelling the first kind 'heavenly volumes' and the second 'earthly volumes'.

But the process of subdivision had much further to go. In the plan published in volume 1 (published in 1954), volume 5 was to contain the following five sections:

- Volume 5: *Chemistry and Chemical Technology*
  - Section 33: Alchemy and Chemistry
  - Section 34: Chemical Technology
  - Section 35: Ceramic Technology
  - Section 36: Mining and Metallurgy
  - Section 37: The Salt Industry

If volume 5 had contained 680 pages, as had volume 3, each section would have had about 136 pages. But just as the 1960s had seen volumes appear in a number of physical parts, the 1970s were to see an even more radical 'multifurcation', and one which would no doubt have horrified the Syndics had it been proposed a few decades earlier: the appearance of a single section in four separate physical parts.

Section 33 became

- Volume 5: *Chemistry and Chemical Technology*
  - Section 33: Alchemy and Chemistry
  - Part 2: Spagyrical discovery and invention: Magisteries of gold and immortality. Joseph Needham, with the collaboration of Lu Gwei-djen (1974): 510 pages
  - Part 3: Spagyrical discovery and invention: Historical survey, from cinnabar elix-

irs to synthetic insulin. Joseph Needham, with the collaboration of Ho Ping-Yu and Lu Gwei-djen (1976): 481 pages
- Part 4: Spagyrical discovery and invention: Apparatus, theories and gifts. Joseph Needham, with the collaboration of Lu Gwei-djen, and a contribution by Nathan Sivin (1980): 772 pages
- Part 5: Spagyrical discovery and invention: Physiological alchemy. Joseph Needham, with the collaboration of Lu Gwei-djen (1983): 574 pages

The reader who is wondering what happened to part 1 of volume 5 will perhaps be reassured to know that it appeared as volume 5, part 1: Paper and printing, authored by Tsien Tsuen-Hsuin (published in 1985). In total, the four parts of volume 5 embodying section 33 contained 2287 pages, about 17 times the number of pages that might have been predicted when volumes 1, 2 and 3 appeared in the 1950s. But far from being in any way disturbed, it appears that the Syndics happily agreed to publish. And they certainly had some motivation for this, quite apart from the scholarly value of these books. The fact is that by 1970, SCC had established itself as a series that many scholarly libraries round the world had decided they should have on their shelves. As a result, each book in that series was automatically ordered in large numbers as it appeared. The resultant income for the press was more than satisfactory. Thus, whereas it is unlikely that the Syndics would have accepted a proposal from Needham for four substantial books on Chinese alchemy in 1960, by 1970, things looked very different.

Let us pause to ask how Needham was able to sustain and develop this immense productivity. In the first place, it is indisputable that he had a capacity for work that most scholars would envy, and that he had an unusual ability to produce coherent text at the first draft as his fingers moved rapidly over the keys of his electric typewriter, after he had soaked himself in the source materials that he surveyed. He could also display a ruthless determination to keep distractions at a distance.

But added to all that were the fortunate circumstances of his life in Cambridge. The only senior academic post he held was that of the Sir William Dunn Reader in Biochemistry,[4] which he held from 1924 to his retirement in 1966, with a period of absence during his wartime work in China, and immediately after in Paris at UNESCO. The University statutes at that time meant that his only strict obligation was to give a certain number of lectures on biochemistry each year, which he did until his retirement. As a result, his abandonment of biochemical research for the SCC project did not threaten his security of tenure or his salary; in addition, he had inherited some capital from his parents that also produced a helpful income. He had been a fellow of Gonville and Caius College since 1924, and was thus guaranteed a room in college and free meals for life; he was elected Master in 1966. And for most of his life, he had the loyal support of two energetic and learned women, his wife Dorothy Needham (like her husband a Fellow of the Royal Society) and Lu Gwei-djen.

I mention these advantages, which most modern researchers can only wonder at, to stress how well and fruitfully he exploited them. He wasted none of his chances, and we should be grateful for that.

4. The later collaborators

During the time I was General Editor, I saw a number of volumes of SCC through the press. Two of these were largely by Needham himself, though they appeared posthumously:

- Volume 6, part 6: Biology and biological technology: Medicine. Joseph Needham and Lu Gwei-djen, edited by Nathan Sivin (published in 2000)
- Volume 7, part 2: The social background: General conclusions and reflections. Joseph Needham, edited by Kenneth Girdwood Robinson, with contributions by Ray Huang, and an introduction by Mark Elvin (published in 2004)

Most of my work was, however, concerned with volumes by collaborators in which Needham had never played any role, apart from noting their topics in his outline of the series. I shall now turn to some

examples of these, which appeared, respectively, in 2004, 2008 and 2015 (a date which rendered it, in a sense, posthumous for me as General Editor, given my retirement the previous year). But how did it happen that Needham felt he had to allow others to publish whole books in the series that he had, in many ways, made a unique expression of his world view as a scientist, a historian and a student of Chinese culture?

When speaking or writing about his project, Needham typically used the pronoun 'we' rather than 'I'. This was a just recognition of the fact that the SCC series in anything like the form it began to take in the 1950s would have been impossible without the work of a number of scholars in addition to Joseph Needham.

For the first three volumes of the series, that collaborator was Wang Ling, who is credited on the title pages as having provided 'research assistance'. To a large extent, this consisted of locating material in premodern Chinese sources that Needham could use in his writing of what was, let us remember, conceived as a pioneering survey rather than a definitive treatment. Needham was certainly well able to read and translate both modern and classical Chinese, but Wang had a speed of comprehension that enabled him to glance through many pages of complex premodern texts and locate promising materials much more easily than Needham ever could. In the three parts of volume 4, other names appear: Part 1 had the 'special co-operation of Kenneth Robinson', who wrote on acoustics, and part 3 also bore the name of Lu Gwei-djen. But in every case, all or the great majority of the words published in the series came from Needham's rapid dactylography on his electric typewriter.

From the 1980s onwards, we begin to see signs of a different kind of collaboration, in which entire books in the series appear as the work of a single collaborator, although Needham's name continues to appear as the overall series author. If we consider Needham's situation in the 1970s, it is clear why he would have felt this necessary.

The plan agreed with the press in 1951 provided for seven volumes, each being a single book. In accordance with this plan, Needham had produced the first three volumes by the end of the decade. That left four more volumes to write, and even if we allow for a rather slower rate of production for these books, they could certainly have been in print by around 1975 or 1980. Since Needham was born in 1900, that might have been thought an appropriate time for him to retire from active research and writing, and enjoy the gratitude of the scholarly world for a magnificent life's work that would have done much to change the way the world saw China, as well as the way that historians of science saw the premodern and early modern world. But it was not to be. The 1960s were mainly devoted to bringing out the three parts of the expanded volume 4, and the 1970s were spent in producing no less than four books on the topic of a single section, that on alchemy.[5] Needham could see clearly that it was unlikely that he would be able to complete his work even if he had suddenly reverted to the original plan of the 1950s, and that it was flatly impossible that the series would ever be completed in the expanded, we may even say the inflated, form that he had allowed it to assume.

It was at this point, already late in life by any normal scholarly standard, that he began to hand over responsibility to others for the writing of major parts of SCC.

This first such book to appear was volume 6, part 2: Biology and biological technology: Agriculture, by Francesca Bray (published in 1984). This was followed by the book on paper and printing (volume 5, part 1) by Tsien Tsuen-Hsuin (published in 1985). Bray was the first author to whom Needham handed over responsibility in this way, and it appears that once he had chosen someone in whom he had confidence, Needham's habit was to let that person get on with the job in his or her own way – at times even when the 'collaborator' would have been glad to have been able to work more closely with him. There was of course one obvious reason for this: Needham was impelled to turn to collaborators in the hope that he would at least be able to finish work on the remaining parts of the series. Such time and energy as remained to him had to be used for that purpose and that purpose alone.

5. A collaborator's volume from (re)start to finish: ceramics

I turn now to the first example of a volume entirely written by a collaborator that was published during

my editorship. In the original 1954 plan, the following section appears:

- Volume 5: *Chemistry and Chemical Technology*
  - Section 35: Ceramic Technology
  - 'History of pottery, porcelain, feldspathic glazes, etc.'

By 1979, when the Needham Research Institute (NRI) prepared a pamphlet on 'The State of the Project' for private circulation, the words 'Digression on cloissoné' had been added. But that was all. When I took over responsibility for the series, I found that this section had been allocated to a collaborator, of whom we need say no more than that there were no apparent signs of activity on that person's part, nor did there seem any great likelihood of the situation changing.

Although, on the basis outlined earlier, this section might have occupied something like 136 pages as part of a single physical volume 5, I also found that in the context of the almost uncontrolled expansion of the series in previous decades, the expectation had arisen that this section would appear as a separate book. In scholarly terms, the idea of a comprehensive survey of the development of ceramic technology in China, set in its fullest historical, social and intellectual context with all the accompanying apparatus of a volume of SCC, was a very attractive one. Given the privileged publishing window offered by SCC at this stage of its development, this was clearly an opportunity not to be missed. After I had outlined the situation to him, Needham accepted my suggestion that we needed to seek a new collaborator who might actually be able to do the necessary work to make this very desirable possibility into a reality.

If one has a demanding task that one wants to see completed within a reasonable timescale and to a high standard, it is commonplace wisdom that one should ask a busy person to take it on. The busy person in question was Rose Kerr, Keeper of the East Asian section, Victoria and Albert Museum, London. To my great delight, she agreed to take the job on, and she in turn was able to persuade Nigel Wood to join her, with particular responsibility for the technical aspects of the topic. Of course, a project like this needs funding, and my next task was to draft the appropriate grant applications. Happily, the Chiang Ching-kuo Foundation agreed to support a 'buy-out' of Rose Kerr from the Victoria and Albert Museum for a year, plus all other research costs. A Leverhulme Trust Senior Fellowship was also obtained for Nigel Wood.

In 2004, 10 years after recommissioning, and half a century after the publication of the original seven-word plan for this section, the book appeared as volume 5, part 12: Ceramic Technology, by Rose Kerr and Nigel Wood, with additional contributions by Ts'ai Mei-fen and Zhang Fukang. As its topic demanded, it was illustrated in colour throughout, the first volume of the series to be given this privilege by Cambridge University Press. It contains 918 pages in all, making it seven times longer than the estimate for a single section under the seven-volume plan. This was a very modest expansion compared with the factor of 17 that Needham had allowed himself for section 33 on alchemy, and was certainly well justified by the importance of the subject and the rich historical scholarship and technical understanding that this book offered its readers. It is unlikely to have any serious competitors for several decades.

6. A closer look at one long but successful story: ferrous metallurgy

In the case of ceramics, the challenge I faced as editor was that of effectively restarting part of the SCC project from scratch, given the complete failure of the original collaborator to make any perceptible progress with the task allocated to (or perhaps imposed on) them by the creator of the series. In other cases, my responsibility was essentially to ensure that a collaborator who was already fully engaged with the task was enabled to bring it to successful completion and publication. I shall briefly discuss two such cases in the order in which the planned volumes eventually appeared.

The story of the first of these begins with the original plan for section 36, Mining and Metallurgy, which appeared in 1954 as follows:

- Volume 5: *Chemistry and Chemical Technology*
  - Section 36: Mining and Metallurgy
  - Ancient Chinese bronze and bronze-casting. Metallurgical formularies in Han books
  - Ancient iron technology: the mastery of cast iron in the Han; iron ploughs and sword forging
  - Metallurgy of the precious metals
  - Knowledge of coal in China and tentatives at coke for smelting. Types of smelting furnaces. The great Ming metallurgical compendium
  - Mining of tin and zinc. Brass and other alloys, some unknown to the West till the +18th century

All this was to be one section within volume 5, planned as a single book. On the usual estimate of 136 pages for a section, the topic of ferrous metallurgy might have been expected to take up no more than 50 pages. It is interesting therefore to note that the draft of the ferrous metallurgy section, published as *The Development of Iron and Steel Technology in China* (Needham, 1958), contains 48 pages. Had Needham continued to work at the same pace on the rest of the section, the result would have been a very valuable short monograph survey of an important topic not so far treated by historians of technology. But this was not to be. Needham himself moved on to other matters, particularly those that eventually appeared in volume 4 of SCC. The parts of the section relating to mining were taken on by Peter Golas, and it was a pleasure to see his valuable contribution appear as volume 5, part 13, in 1999. The parts of the section dealing with nonferrous metallurgy were allocated to collaborators who proved unproductive, and I was happy to be able to transfer responsibility for this topic to Mei Jianjun, now my successor as Director of the NRI. But what had happened to ferrous metallurgy?

After the publication of Needham's short monograph in 1958, there are no further signs of work on this topic over 20 years, until 1981, when Needham left the following note in his ferrous metallurgy file:

> Donald Wagner @ Ostasiatika Institutet Copenhagen / v. keen on hist. [history] of i. [iron] & s. [steel] in [China] might collaborate

Needham's first idea was essentially to ask Wagner to revise the short draft on ferrous metallurgy that he had already completed and published, since he was fully aware that the archaeology and scholarship of the preceding two decades had rendered his previous work outdated. But the conception of the task appears to have expanded rapidly in harmony with other aspects of Needham's original plan, and by 1992, it had been agreed that Wagner was to produce a complete book on this topic. Once more thanks to a grant obtained by the NRI from the Chiang Ching-kuo Foundation, Wagner was able to spend several years in Cambridge working on his book without distraction, and it was published as volume 5, part 11, in 2008 – 54 years after the publication of the original plan. Once more SCC offered the window for publication of a lengthy and comprehensive work of scholarship that will provide an entry point into its subject for decades to come.

7. (Ethno)botany: SCC reflects on itself

If we look at the outline given for volume 6 in the 1954 plan of SCC, we see:

- Volume 6: *Biology, Agriculture and Medicine*
  - Section 38: Botany
  - Botany and plant sciences in the great series of pharmaceutical compendia
  - Development of the classification system
  - Special monographs in the Sung [the Song dynasty]
  - Discovery of sex in plants; plant abnormalities and so on.

The whole of volume 6 as then planned was to be contained in a single book, covering sections 38 to 45 – Botany, Zoology, Biochemical Technology, Agriculture, Agricultural Arts, the 'Institutes of Medicine' (specified as Anatomy, Physiology and Embryology), Medicine and Pharmaceutics. In terms of space in the plan, Botany represented about

one-twelfth of the whole. On the basis of the 680 pages of main text in volume 3, that would have given Botany a little under 60 pages – slightly longer than what we saw earlier might have been occupied by ferrous metallurgy.

If we look at the plans for botany published in the 1979 pamphlet, it is clear that there had been great developments during the preceding quarter of a century. Volume 6, of which section 38 'Botany' had originally been described in four lines, was now planned to appear in four parts, with sections 38 to 42 composing parts 1 and 2, while sections 43 to 45, dealing with medical matters, were to be dealt with in parts 3 and 4. The plan for section 38 occupied more than 60 lines in the pamphlet plan, and much of it had in fact already been drafted. It is at this point that the name of Georges Métailié first appeared in print in association with SCC: under the heading for parts 1 and 2 in the pamphlet, we read 'With the collaboration of Lu Gwei-djen, Georges Métailié, and Francesca Bray'.

To trace the background of this story, we may turn to the correspondence files of the SCC project, carefully filed away at the NRI. Inside a green folder, labelled 'SCC VI Bot', we find another folder bearing the name 'Georges Métailié'. The earliest slip of paper in that folder is dated '16 Dec. 78', with a box round the words 'BOTANY Section, finishing of'. Clipped to that slip is the *curriculum vitae* of a young French researcher in his 30s, who describes himself as being in the process of completing a 'doctorat d'état' on the history of botanical vocabulary in China and Japan in the 19th century, after having completed a PhD in 1974. Plans for an initial visit to Cambridge in the first 6 or 7 months of 1979 are outlined, concluding with the note by Needham that once the work was underway, the new colleague 'could work in Paris, + xeroxed files of notes, coming once or twice for coupla [*sic*, = 'a couple of', i.e. two] weeks'.

But as time went by, it became clear that, like all tasks to do with SCC, this one was less simple to complete than it might have appeared at first sight. Métailié's job involved his participation in an official French mission to China in the immediate short term and gave him few opportunities to work on SCC-related topics. There was also a major project for a dictionary of agriculture that was eventually to be published in 1995 (Métailié and Cai, 1995). This project involved Métailié working with and managing a number of collaborators of his own.

Nevertheless, in March 1981, only 3 years after asking his new collaborator to begin work, Needham began to apply pressure. When writing in reference to an impending visit to Cambridge by Métailié, Needham added a significant sentence:

> We are longing for [the volume on Botany] to be able to go to press, and I must say that the CUP [Cambridge University Press] themselves are trying to hasten more the publication of the volumes, so that they are very eager to receive typescript.

Reference is also made in this letter to the contribution to be made to the book by Huang Hsing-Tsung (Huang Xingzong, once Needham's secretary in wartime China, but by 1981 working with the National Science Foundation in Washington, DC), who had been given responsibility for the parts of section 38 dealing with biological plant protection. Further correspondence renewed the topic, until in February 1983, Needham announced that those portions of the Botany volume then available in finished form, including most of the contribution by Huang Hsing-Tsung, had gone to press, and galley proofs were imminently expected. In April of that year, Needham wrote that 'I think it is now agreed that we should print the breakdown of all the sub-sections of the chapter in Vol. VI, part 1, leaving your remaining portion to come in a later volume'.[6]

SCC volumes passed rather more slowly through the press in those days, and in the event volume 6, part 1, containing 553 pages of main text, did not actually appear until 1986, 32 years after the original plan of 1954. When readers turned to the contents pages, they found that section 38 had been divided into alphabetically divided subsections labelled (a) to (k). Subsections (a) to (d) were by Needham and Lu Gwei-djen, and comprised[7]

(a) Introduction

(b) The setting: China's plant geography

(c) Botanical linguistics

(d) The literature and its context.

Huang Hsing-Tsung was responsible for

(e) Plants and animals in man's service.

After the usual details of bibliographies, the index and auxiliary tables, there is a white space, followed by these words enclosed by rules:

> The following subsections, by Georges Métailié, are not yet ready for publication

After which the subsections still to come are listed as

(f) Treatises on traditional botany, and the development of classification

(g) The development of plant description and illustration

(h) Chinese knowledge of the life of plants

(i) Horticulture and its techniques

(j) The influence of Chinese flora and botany on modern plant science

(k) Conclusions

In his preface, Needham wrote,

> The present volume contains most of section 28 [*sic* – an uncorrected typographical error for 38], on the plant sciences. We cannot say all, because there will still be more to come in a following volume, the work of our collaborator Dr Georges Métailié . . . It would no doubt have been preferable to bring it all out together in one volume, but the necessities of collaboration and the interlocking of commitments have made it impossible.

In July 1986, Colin Ronan (at the time Secretary of the East Asian History of Science Trust) replied to an enquirer by referring to Métailié's work as being planned to appear in 'the second botany volume' of SCC. It is clear that those working with Needham had tacitly moved from the original notion of the remaining botanical material finding a place in some later volume of the series, to the assumption that there would be a completely independent further volume on botany, written by Métailié. By April 1988, it was clear that the issue had been settled in favour of a separate 'earthly volume', and Métailié gave as his estimate that the typescript for this new volume would consist of around 400 pages.

Time (once more) passed. When in 1992 I became General Editor of the SCC series, the state of affairs with Métailié's book was one of the matters I reviewed. I was a little concerned to learn that there was an understanding between Needham and the author that the text of this volume would be drafted in French, but I dealt with this problem as far as I could by earmarking funds for the eventual employment of an expert translator, whose skills would obviously be required in order for the book to be published in English with the rest of the series.

Work on the series continued over the next two decades. Nine further (earthly) volumes were published under my General Editorship. Finally, in February 2011, I was able to report to the NRI Board of Trustees:

> We [have] received the final instalment of MS [manuscript] from [Georges Métailié], and have now been sent very favourable reports from the two specialist readers. We therefore begin the complex process of preparing this long-awaited volume for publication, a task which we view with all the more satisfaction considering how long the author has been working on this major project.

But as already mentioned, Métailié's complex and scholarly text was all in French. However, I was in the extremely fortunate position of having by then agreed with Lady Lloyd (Janet 'Ji' Lloyd) that she would take on the very demanding task of translation. As anyone familiar with the range of scholarly work that had already been handled by this expert and sensitive translator will understand, I felt complete assurance that the resulting version would be the best that could possibly be produced. Anybody who reads the book as it now stands will agree that my assurance was justified in the event. In late 2013, we had before us a fully translated text, agreed with the author, and could begin to carry out the final tasks required before sending the book to press.[8] So, 36 years after Georges Métailié agreed to Needham's

request to help finish his book on Botany, his book appeared.

Some words of Métailié in his preface show us that the time taken for this project had given this author the opportunity for deep reflection on the nature of the task he had undertaken. As a result, he set down on paper what I think is the first significant example of an SCC collaborator's critical reflection on the nature of the task he had been set:

> In accepting the proposal made by Joseph Needham and Lu Gwei-djen, I had in effect accepted the idea that a form of clearly defined botany did exist in ancient China, given the voluminous corpus of texts to be analysed. However, as my reading proceeded, I was forced to admit, in the first place, that I had come across no Chinese term that might have even one of the modern meanings of 'botany'. Furthermore, nor had I found any term that referred to any traditional knowledge specifically about plants before the creation, in 1858, of the term *zhiwuxue*植物學, meaning botany in the modern sense of the term. Finally, among the abundant literature that I was working through, there was no text that could be regarded as a kind of botanical manual, nor was there any reference to what we call a flora. So was there no botany in China at that time?

To ask such a question is, in effect, to turn the spotlight on what has, over the past 60 years, come to be seen as a controversial assumption behind the whole structure of the SCC project, first stated by Needham in 1977 in the following words, which Métailié quotes:

> I suppose we all generally agree that there is only one unitary science of nature, approached more or less closely and built up more or less successfully and continuously, even if very slowly, by the several groups of mankind from age to age. This means that we could expect to trace an absolute continuity between the first beginnings of astronomy and medicine in ancient Babylonia or ancient Egypt, through the advancing natural knowledge of mediaeval China, India, Islam and the classical Western world, to the break-through of late Renaissance Europe when, as has been said, the most effective method of discovery was itself discovered. (Needham, 1977)

Reading these words written over 40 years ago, most historians of science would be able to do no more than say 'Well, up to a point . . .' The nature of Métailié's sensitive and deeply informed response is set out in his book and cannot be discussed in detail here. The important thing is, however, that with Métailié's book, we can say that SCC has become reflexive and has begun to discuss the assumptions that underpinned its creation. That is not a bad moment for me to bid farewell to the series now that it has passed into other hands.

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Notes

1. In 1992, I became Deputy Director of the Needham Research Institute (NRI) in parallel with my full-time job in the department of history at the School of Oriental and African Studies (SOAS) in London. I worked under the new Director of the NRI, Ho Peng Yoke, who had taken over in 1990 when Needham decided to retire. I also became chairman of the NRI Publications Board and General Editor of the SCC series. In theory, all this took up no more than the one working day a week away from London allowed by the terms of my contract with SOAS. I was able to work full-time for the NRI after being appointed Director in 2002 in succession to Ho Peng Yoke.
2. The original sentence is 'Laws, like sausages, cease to inspire respect in proportion as we know how they are made'. It is commonly attributed to Prince Otto von Bismarck (1815–1898), but is said by Fred R. Shapiro to have first appeared in the Cleveland Herald in 1869, attributed to the poet John Godfrey Saxe (1816–1887), more than half a century before it began to be attributed to Bismarck. See: Shapiro (2008; online edition: said to have appeared in print on page MM16 of the *Sunday Magazine*).
3. At the time Needham planned his work, it was fairly normal practice among historians of science to use the contemporary view of the structure of science to give shape to their study of the past. In addition, since Needham was planning to survey a largely unexplored field, it would have been unwise for him to begin by attempting to decide at the outset how human

understanding of nature was actually constructed in premodern China. (For such an attempt, made to some extent in the light of Needham's work, see Sivin, 1977: Introduction.) Most of the time, Needham's chosen structure did not pose significant problems in his writing and that of his collaborators. In two cases, it proved difficult to make the evidence of premodern Chinese thought and practice fit into modern structures. Thus, there is no *SCC* treatment of zoology, not because Chinese people did not have systematic knowledge of animals from many aspects (agriculture, veterinary medicine, cosmological correlation), but because there was no overall concept of 'the study of animals' in its own right. The problems that arose with botany will be discussed near the end of this essay.

4. A Reader in British usage at that time was above a Lecturer in status and salary, but below a Professor.
5. We may also mention substantial works outside *Science and Civilisation in China* (SCC), one of which (see Needham et al., 1960) contained original research, while the others (see Needham, 1969; Needham et al., 1970) were essentially edited talks and articles appearing in book form. Needham is also named as the second author of a research monograph (see Lu and Needham, 1980).
6. Needham seemed quite happy with the idea that collaborators' contributions that were not ready to be published with his own work, such as Métailié's, could be fitted in somewhere at a later stage, perhaps by 'mak[ing] up a volume consisting of various contributions' (letter from Needham to Métailié dated 14 June 1982). Consistency of topic was not necessarily a primary consideration in such plans. Needham had for instance hoped that material drafted by Lo Jung-pang on deep drilling and the salt industry might find a place in Francesca Bray's book on Agriculture, to which it would not have been very relevant (see volume 6, part 1, Preface, xxiv–xxv, and the letter referred to above). Of course, the topic of the salt industry (section 37) properly belonged in some part of volume 5 *(Chemistry and Chemical Technology)* rather than anywhere in volume 6 *(Biology and Biological Technology)*.
7. I omit here and below the more detailed analyses of the content of each subsection given in the original.
8. These included, among other things, securing the complex copyright permissions required for the book's many illustrations. Much gratitude is due to the institute's librarian, John Moffett, for his persistence and skill in helping to ensure that all that was needed was eventually put in place.

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Christopher Cullen studied engineering science at the University of Oxford, and later did a PhD in classical Chinese at the School of Oriental and African Studies, University of London. He became Deputy Director of the NRI in 1992, then held the post of director from 2002 to 2014. His recent publications include *Heavenly Numbers: Astronomy and Authority in Early Imperial China* (Oxford University Press, 2017) – a narrative history of the foundational period of Chinese astronomy, 3rd century BCE to the 3rd century CE – and *The Foundations of Celestial Reckoning: Three Ancient Chinese Astronomical Systems* (Routledge, 2017) – translations of source materials, with detailed explanations.